CULEX (CULEX) MOLESTUS FORSKÅL (DIPTERA: CULICIDAE): NEOTYPE DESIGNATION, DESCRIPTION, VARIATION, AND TAXONOMIC STATUS[1]

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Abstract.—A neotype male and alloneotype female from Rosetta, Egypt, are designated and described for *Culex molestus* Forskål, 1775. The male, female, pupa, and larva are described and illustrated. Variation encountered in the adult, pupal, larval, and egg stages is discussed. The taxonomic status of *molestus* is discussed and evaluated in light of morphological, behavioral/physiological and crossing variations. A decision is made regarding the status of *molestus* that will help stabilize the nomenclature of the *pipiens* complex.

The species, subspecies, and infraspecific forms that have been and still are attributed to the *pipiens* complex of *Culex (Culex)* represent one of the major outstanding problems in mosquito taxonomy. This problem has persisted for decades because of interpretational difficulties and controversy associated with a number of perplexing biological issues: autogeny/anautogeny, stenogamy/eurygamy, anthropophily/zoophily/ornithophily, homodynamy/heterodynamy, morphology (including DV/D and D/V ratios, and siphon indices), taxonomy (absence of type-specimens and misidentifications), distributions (confounded by introductions) and hybridization (hybrid swarms, and crossing studies confused by rickettsial symbionts). A world-wide study of these issues is desirable; unfortunately a comprehensive undertaking is beyond the scope of this study. However, for nomenclatural purposes, problems such as the absence of type-specimens can be resolved, and certainly should be, because the delimitation and fixation of names form the basis for taxonomic concepts.

During the past four years the senior author has been working on the taxonomy of the *pipiens* complex in the Middle East, and more recently on a revision of the *Culex (Culex)* of northern Africa and southwestern Asia. These efforts have highlighted the taxonomic instability and misunderstanding surrounding the identification of members of the *pipiens* complex in this region. Marshall and Staley (1937), Jobling (1938), Marshall (1944), Knight (1951), and Christophers (1951) attempted to outline stable morphological characters for *Cx. molestus* Forskål,

and other members of the *pipiens* complex. However, since the 1950's it has become more apropos to define *molestus* on the basis of behavioral and physiological traits. *Culex molestus* was recently elevated to specific status on the basis of premating isolation behavior (Miles 1977a, Knight 1978) between members of the *pipiens* complex in Australia. Unfortunately, no attempt has been made to define *molestus* morphologically, as originally described by Forskål prior to the use of behavioral and physiological traits.

Recently, Belkin (1977) firmly established the priority of *Cx. quinquefasciatus* Say over *Cx. fatigans* Wiedemann, and Sirivanakarn and White (1978) designated a neotype to fix the identity of *quinquefasciatus*. We feel that similar stabilization is badly needed for *molestus* and other nominal forms, and is essential for resolving the taxonomy of the *pipiens* complex.

BACKGROUND AND METHODS

Past efforts to resolve the taxonomic status of *molestus* were hampered because of uncertainty about the location of Forskål's type-specimens. For this reason, there have been no prior attempts to designate a neotype for this species. However, we believe that the original specimens of *molestus* are non-extant and that a neotype should be designated.

According to Zimsen (1964) and Knight (1972), Petrus (Peter) Forskål died 12 years before the description of *molestus* was published posthumously by Carsten Niebuhr (Forskål, 1775). Forskål succumbed, presumably to malaria, during the "Arabian Journey," a scientific expedition to Egypt and other Arab countries that was supported by the Danish Government. Before his death, Forskål sent collections of natural history specimens home, but some of these were lost en route. Specimens of *molestus,* if they were ever sent, may have been part of the collections which never reached their destination. All attempts to locate Forskål's specimens of *molestus* have failed. Stone et al. (1959:256) and Knight and Stone (1977:219) indicate that the location of type-material is unknown. In fact, there are handwritten notes in the Stone/Knight files in the NMNH indicating there is "negative evidence" for the existence of type-specimens for *molestus*. Although Linnaeus received Egyptian and Arabian specimens from Forskål, there is no evidence that mosquitoes were included (Jackson, 1913). Zimsen (1964) mentions that a number of insect species described by Fabricius came from the Forskål collections; however, none of the mosquitoes described by Fabricius came from Egypt or Arabia. Furthermore, a recent check of the Universitetets Zoologiske Museum, Copenhagen, revealed there are no specimens of *molestus* associated with the Fabricius Collection (L. Lyneborg, personal communication).

We made extensive collections of immature mosquitoes in Egypt between 15 March and 13 May, 1983. Areas surveyed in the south included Abu Simbel near the Sudanese border, the Nile Valley from the Aswan High Dam north to Idfu, and the Red Sea coast between Qusier and Bernice. Areas surveyed in the north were Siwa Oasis, El-Faiyum, the Red Sea coast from Suez to Ras Shukheir, and the Nile Delta. While working in the Nile Delta we made collections in Rosetta, Cairo, and Alexandria, the three specific type-localities for *molestus*. Adults matching Forskål's description of *molestus* were reared from all the areas collected. A neotype (specific information is provided with the designation below) and alloneotype were selected from material collected at Rosetta. Specimens reared

with the neotype and alloneotype include 14 adults (3 males with pupal exuviae; 3 males and 8 females with both larval and pupal exuviae) and 16 fourth-instar larvae. Material collected in Rosetta was also colonized for behavioral/physiological studies. About 380 specimens were obtained from Cairo and Alexandria: some 64 males, 87 females, 151 pupal exuviae, 60 larval exuviae, and 20 fourth-instar larvae. In all, more than 1500 adults, approximately 90% with larval and/or pupal exuviae, and hundreds of fourth-instar larvae were obtained from 87 of 175 collections made in Egypt.

Detailed descriptions and illustrations of the adult, pupal, and larval stages of the neotype are provided. Characters which differ in the alloneotype are described, and some important adult sexual differences are illustrated. A description of diagnostic and variable characters for each life stage based on associated specimens is also included. Character measurements, setal counts, and setal branching counts were made on the neotype and alloneotype, and 10 specimens collected with them. The morphological terminology follows Harbach and Knight (1980), except that siphon indices were calculated using the basal width of the siphon rather than the width measured at midlength.

A translation of Forskål's original Latin description of *molestus* precedes the description of the neotype. It is included to show that the neotype and associated material conform to Forskål's concept of *molestus*. Additional evidence for this conformity is given in the discussion.

Culex (*Culex*) *molestus* Forskål

Culex molestus Forskål 1775: 85.

"CULEX molestus; *antennae with whorls of pile; proboscis ash-colored, apex black, rather thick; dorsum dark, with six pale bands.*

"Descr. *Size* and appearance of the *common Culex pipiens* [or perhaps, "*common twittering Culex*"]. *Eyes* greenish, consisting of numerous little globules. *Front* dark as well as the *Thorax*. *Proboscis* subclavate, that is thicker toward the apex and black; lower part ash-colored. *Antennae* setaceous, somewhat shorter than proboscis, furnished with large pilose whorls, about 13, as I would see them, base with a single segment. Bare indeed as perceived by the eyes, but poorly; because between them [pedicels?] are dense, erect, small hairs; one must use a microscope. *Lower thorax* and abdomen ashy-white. *Dorsum* dark, suture of segments 6 and 7 pale. Whole body and *Legs* pilose: femora ash-colored: tibiae dark. *Wings* dark, posterior margin ciliate. *Halteres* ash-colored, knob dark.
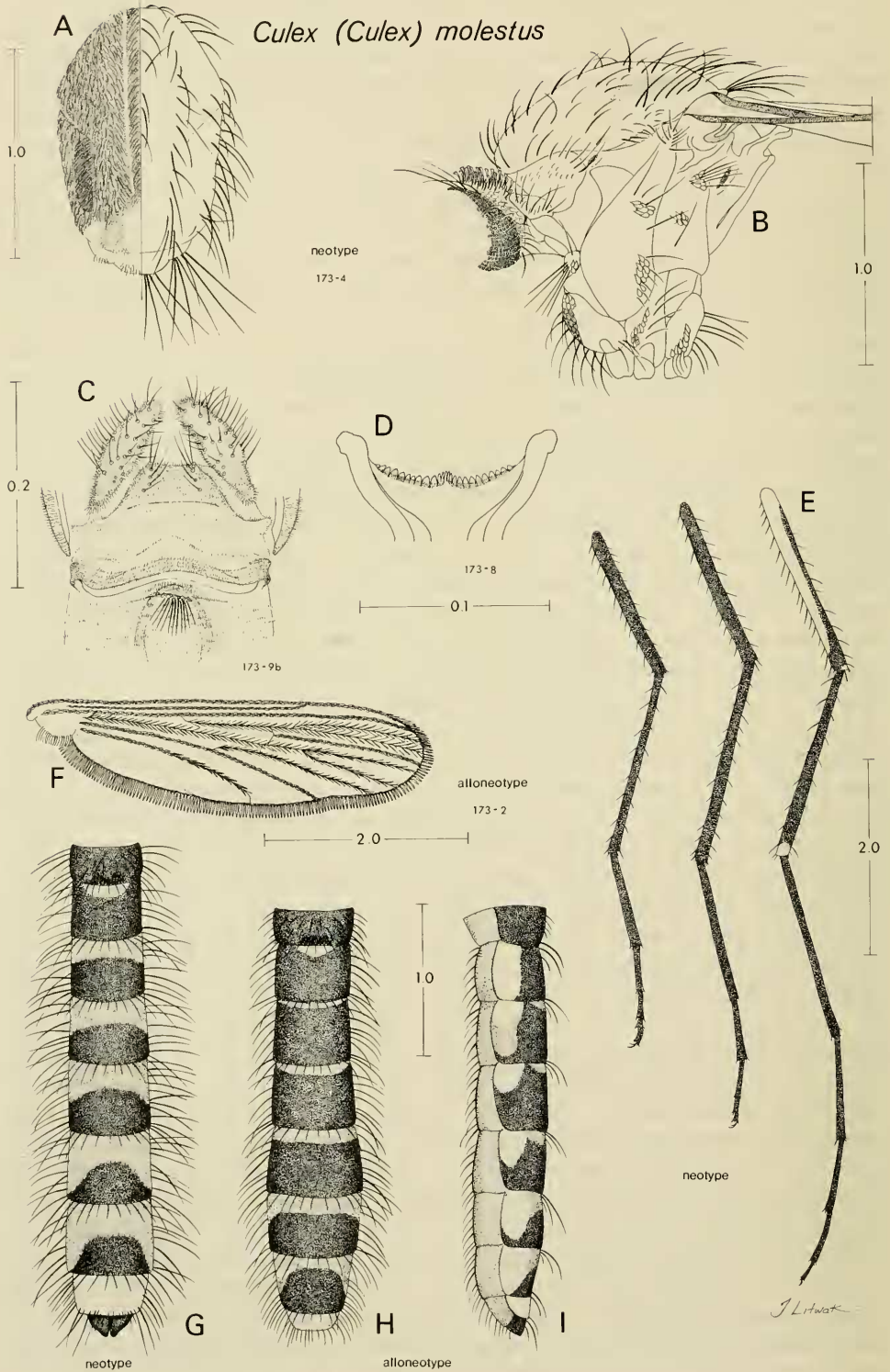
"*Rosetta, Cairo* and *Alexandria* tremendously abundant, bothers sleepers at night and difficult to avoid them unless with well-closed curtains."

Neotype (hereby designated): ♂ (173-4) with associated larval and pupal exuviae and genitalia on slides, Rosetta (= Rashid), Buhayrah Gov., Egypt, 6 May 83, ground pool with organic pollutants 2–3 m from open cesspit, Coll. Harbach/ Gad. Deposited in the National Museum of Natural History, Washington, D.C., Type No. 101367.

Male (neotype) (Figs. 1, 2).—A medium-sized mosquito without striking features and special ornamentation. *Head:* Length of antennal flagellum 1.4 mm; flagellomeres 1–12 pale between whorls; flagellomeres 13 and 14 dark, length about 0.6 mm, approximately 0.4 of flagellum length; pedicel dark, paler laterally.

Proboscis without ventral cluster of setae near false joint; mainly black-scaled, with ventral patch of cream-colored scales 0.5–0.7 from base; length 2.1 mm, false joint 1.3 mm from base; labella yellowish. Length of maxillary palpus 2.5 mm, 1.2 of proboscis length, extending beyond tip of proboscis by nearly length of palpomere 5; palpus mainly dark-scaled, integument between palpomeres 2 and 3 pale; lateral surface of palpomere 3 with subtle stripe of creamy-white scales in middle, stripe bordered ventrally by row of long dark setae on distal 0.5 of palpomere, with ventromesal row of small antrorsely-curved pale setae along most of length; palpomere 4 with nearly complete ventral stripe of white scales tapering distally; base of palpomere 5 with small ventral patch of white scales; long lateral setae of palpomeres 4 and 5 longest at base of 4, gradually shortening to apex of 5. Forked scales of vertex rather short, dark, some paler medially; falcate scales narrow, pale yellow, paler laterally; lateral spatulate scales creamy white. Ocular setae dark reddish brown, curved anteriorly. Interocular space narrow, with few pale falcate scales continuous with those of vertex and 2 large, golden setae projecting ventrally over clypeus. *Thorax* (Fig. 1A, B): Pleural integument faded yellowish brown; scutal integument brown, paler laterally. Scutal scales fine, golden brown with slight reddish tint; scales finer on fossae and supraalar areas; integument and scales between supraalar and posterior dorsocentral setae noticeably darker, evident as pair of ovoid spots, particularly when viewed in dorsal aspect; pale yellow scales on margin of prescutellar area. Scutal setae dark reddish brown, prominent. Scutellum with narrow, pale yellow falcate scales; 5 large setae on each lateral lobe, 7 on median lobe. Antepronotum with pale yellow falcate scales and dark setae. Postpronotum with golden-brown falcate scales, paler posteriorly; with 6 dark setae on posterodorsal margin, longer posteriorly. Pleural setae golden brown, numbers on left side as follows: 13 upper proepisternal in more or less double row, 10 prealar, 4 upper mesokatepisternal, 6 lower mesokatepisternal, 6 upper mesepimeral and 1 lower mesepimeral. Pleural spatulate scales nearly white: few below upper proepisternal setae, patches on upper corner and lower posterior border of mesokatepisternum, anterior patch on mesepimeron at level of upper mesokatepisternal patch, and small patch before upper mesepimeral setae; without prealar and postspiracular scales. *Wing:* Length 3.1 mm; cell R_2 2.4 of R_{2+3}; subcosta intersects costa before furcation of R_{2+3}; cell M_1 0.7 of cell R_2; scales entirely dark. Dorsal scaling: squame scales on costa, subcosta, R, R_1, R_{4+5}, M_{3+4}, mcu and CuA; plume scales on R_s, R_{2+3}, R_2, R_3, M, M_{1+2} and distally on 1A; near-linear decumbent scales on M_1, M_2 and proximally on 1A; remigium with 2 distinct rows of scales, and 3 setae distally. Ventral scaling: squame scales on costa, subcosta, base of R_1, R_s, R_{2+3}, bases of R_2 and R_3, M, M_{1+2} and bases of M_1 and M_2; plume scales on other veins and parts of veins except CuA before mcu and proximal 0.75 of 1A which are without scales. *Halter:* Scabellum and pedicel yellowish brown, capitellum with black scales. *Legs* (Fig. 1E): Anterior surface of forecoxa mainly black-scaled, with small basal patch of yellowish scales, anterior surface also with many long, brown, ventrally-curved setae, apex with 3 shorter setae on posterior margin, most proximal seta more or less perpendicular to surface, others project ventrally; midcoxa with midlateral longitudinal row of 4 well-developed golden-brown setae and longitudinal patch of creamy-white spatulate scales on anterior side of setae, anterior surface with few black scales and several short ventrally-projecting setae at apex; posterolateral

surface of hindcoxa with 7 golden-brown setae, anterolateral surface with narrow longitudinal row of creamy-white spatulate scales and 4 short ventrally-projecting setae at apex, mesal surface with 2 dark setae at apex. Trochanters with nearly white spatulate scales on posteroventral surface, anteroventral surface of fore- and midtrochanters with some black spatulate scales. Anterior surface of forefemur with black scales, posterior surface with off-white scales, apex with subtle narrow border of pale yellow scales dorsally; midfemur like forefemur but black scaling extended over dorsal surface distally; hindfemur with complete anterodorsal stripe of black scales, stripe gradually expanded distally onto anterior and posterior surfaces, apex with narrow border of pale yellow scales dorsally. Foretibia with black scales dorsally, gray scales ventrally; midtibia with black scales anteriorly, off-white scales posteriorly; hindtibia mainly with black scales, posteroventral surface with gray scales, anterodorsal surface with subtle spot of grayish-white scales at apex. Tarsi black-scaled, scales slightly paler ventrally, particularly on tarsomere 1. Pulvilli pale. Ungues black; anterior foreunguis longer than posterior one, both stout, anterior one with small ventral tooth near midlength, posterior one with small tooth nearer base; anterior midunguis like that of foreleg, posterior midunguis smaller, more slender, with tiny ventral tooth near midlength; hind-ungues very small, simple. *Abdomen* (Fig. 1G): Terga mainly black-scaled; tergum I golden setose, with some median black scales on posterior border; posterior margins of terga II–VII with row of golden setae, median setae nearly length of basal band of next tergum, lateral setae longer, about 0.75 of tergum length; lateral scale-free areas of terga II–VII with long laterally-projecting golden setae; tergum II with basomedian yellowish spot; terga III–VII with basal yellowish bands 0.4 of tergum length, bands produced posteriorly along lateral scale-free areas, particularly on terga V–VII, giving them a concave appearance; tergum VIII (ventral in position) with golden setae and yellowish scales, posterior margin slightly emarginate in middle with row of rather short setae on either side of emargination. Sterna II–VII pale (same color as basal bands of terga) with few median black scales; sternum VIII (dorsal in position) with dingy white scales; all sterna golden setose. *Genitalia* (Fig. 2C–H): Ninth tergal lobes small, with 8 and 10 unevenly-spaced setae on left and right lobes, respectively. Gonocoxite normal, ventrolateral setae strongly developed, these longer and stouter than lateral setae, mesal surface with 5 rows of small setae extending from base to level of subapical lobe; subapical lobe undivided, setae a–f in more or less straight row with gap between c and d, seta g immediately lateral to d–f, seta h lateral to g; a–c nearly straight, a and b stout, c more slender, apex of a blunt, apex of b and c hooked and pointed; d–f shorter than a–c, hooked apically, d and e slender, f laterally flattened and appearing broad in lateral view; g foliform, evenly rounded distally; h slender, bent distally. Gonostylus stout, curved and tapered distally, with 2 small, slender setae on distal 0.3 of slightly concave dorsal surface; gonostylar claw short, broadest apically, troughlike. Phallosome longer than broad with lateral plates and aedeagus of nearly equal length; lateral plate with definite dorsal, lateral and ventral arms, dorsal arm broad, apex nearly truncate, slightly sinuous in lateral aspect and diverging from its mate of the opposite side; lateral arm broad in lateral view, its posterior margin more or less trilobed, the ventral lobe more prominent than the others and bent ventrolaterally, base of lateral arm with thumblike dorsal process, base of this process continuous mesally with dorsal aedeagal bridge; ventral arm

Culex (Culex) molestus

A

1.0

neotype

173-4

B

1.0

C

0.2

D

173-8

0.1

E

F

alloneotype

173-2

173-9b

2.0

2.0

G

neotype

H

alloneotype

I

1.0

neotype

J. Litwak

narrow and curved with apex directed laterally. Aedeagus subcylindrical, narrowed distally; ventral aedeagal bridge relatively wide, joining aedeagal sclerites just beyond midlength. Proctiger without distinctive features; paraproct with small, conical basal lateral arm, crown dark with numerous short, spinelike spicules. Cercal sclerite elongate, irregularly shaped; 4 and 3 cercal setae on left and right sides, respectively. Tergum X rectangular, adjoining paraproct below basal lateral arm.

Alloneotype: ♀ (173-2) with associated larval and pupal exuviae and same data as neotype.

Female (Alloneotype).—Like neotype except as follows. *Head:* Length of antennal flagellum 1.9 mm, entirely dark, pedicel and flagellomere 1 with tiny white scales on mesal surface, mesal surface of pedicel also with tiny setae. Proboscis length 2 mm; proximal 0.7 of ventral surface with cream-colored scales. Maxillary palpus entirely black-scaled; length 0.4 mm, about 0.2 of proboscis length. Forked scales of vertex more numerous, entirely dark. *Cibarial armature* (Fig. 1D, described and illustrated from specimens collected with the alloneotype): Cibarial crest concave, slightly produced in middle; with about 25 short, blunt teeth, several teeth in middle narrower and longer. Cibarial dome nearly elliptical in dorsal outline, slightly produced anteriorly in middle; surface with imbrication of pointed scalelike markings. *Thorax:* Scutal and pleural scales and setae same as neotype except ovoid spots between supraalar and posterior dorsocentral setae indistinct; numbers of some pleural setae on left side differ as follows: 8 upper proepisternal, 8 lower mesokatepisternal and 7 upper mesepimeral. *Wing* (Fig. 1F): Length 3.7 mm; cell R_2 4.8 of R_{2+3}; subcosta intersects costa beyond furcation of R_{2+3}; cell M_1 0.8 of cell R_2; remigium with 3 setae on left wing, 2 on right wing. *Legs:* Like neotype except midcoxa with 5 setae in midlateral row; hindcoxa with 8 setae on posterolateral surface. Ungues very small, simple. *Abdomen* (Fig. 1H, I): Tergum I with median posterior pair of black scale-patches; tergum II with basomedian spot of yellowish scales and lateral patches of white scales; terga III–VII with basal bands of yellowish scales and rather large basolateral spots of white scales, bands 0.25 of tergum length, slightly convex on terga III and IV and not reaching spots, straight on terga V–VII and contiguous with spots; tergum VIII white-scaled. Sterna II–VII with yellowish scales, with few subtle dark scales in middle; sternum VIII with whitish scales on lateral margins, broad median area devoid of scales. *Genitalia* (Fig. 1C, described and illustrated from specimens collected with the alloneotype): Sternum VIII with rounded median posterior emargination. Tergum IX narrow, posterolateral margin of either side with irregular row of 7–13 setae. Upper vaginal lip narrow, distinct; lower vaginal lip and insula indistinct; 8–12 insular setae in dense transverse row. Upper vaginal sclerite distinct; U-shaped. Postgenital lobe short, apex slightly concave to rounded, row of 6–8 setae on either side of midline extending from dorsal to ventral surface over apex. Cercus

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Fig. 1.   *Culex* (*Culex*) *molestus* Forskål. A, Scutum of neotype male. B, Thorax of neotype male (left side). C, Female genitalia. D, Female cibarial armature. E, Legs of neotype male (anterior aspect of left legs). F, Right wing of alloneotype female (dorsal). G, Abdomen of neotype male (dorsal). H, I, Abdomen of alloneotype female (H, dorsal; I, left side). Scales in mm.

Culex (Culex) molestus
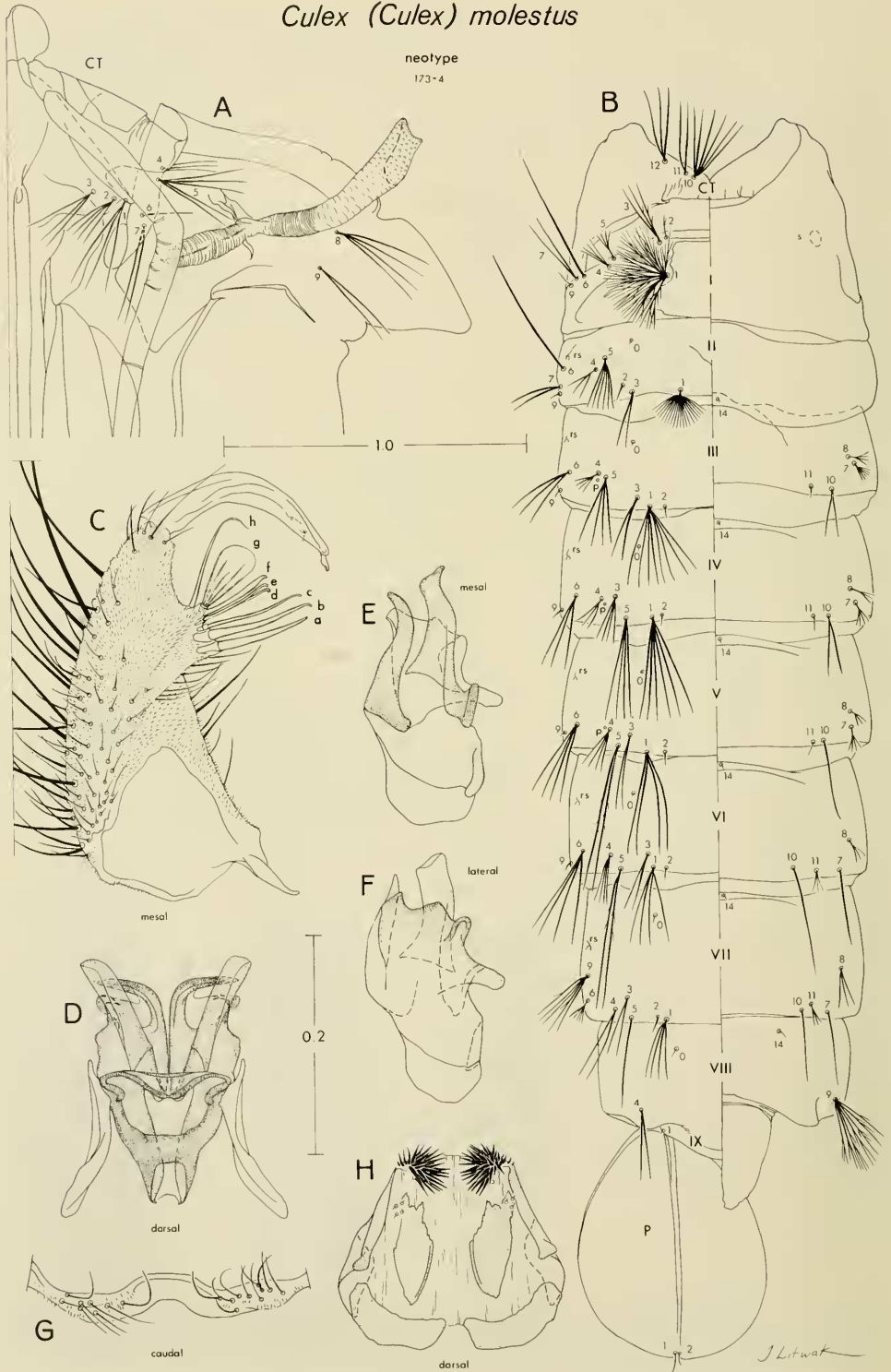
short, laterally compressed, broad in lateral view, apex bluntly rounded, lateral and ventral surfaces setose; cercus/dorsal postgenital lobe index 2.80–3.10.

The following variation was observed in specimens collected with the type-specimens. *Head:* Proboscis length 1.9–2.1 mm, mean 2.0 mm; length of maxillary palpus 0.4 mm in females (proboscis/palpus 5.0–5.3), 2.2–2.5 mm in males, mean 2.3 mm (palpus/proboscis 1.10–1.26, mean 1.18). *Thorax:* Ovoid spots of scutum often indistinct in females, when distinct, acrostichal and fossal scales sometimes equally dark and distinct; ovoid spots usually distinct in males. Postpronotum usually with 6 setae (5, 6); pleural setae: usually 8 or 9 upper proepisternal (7–15), 5–11 prealar, usually 4 upper mesokatepisternal (3–5), 5–8 lower mesokatepisternal, 4–9 upper mesepimeral. *Wing:* Length 3.6–3.7 mm in females, 2.8–3.1 mm in males; cell R_2/R_{2+3} 4.6–6.0 in females, 2.4–3.3 in males; subcosta intersects costa beyond furcation of R_{2+3} in females, at or before furcation in males; cell M_1/cell R_2 0.7–0.8. *Abdomen:* Basal bands of terga always yellowish, shape variable; basomedian spot of tergum I sometimes nearly or entirely lost; basal bands of terga III–VII either convex, straight or concave, bands of terga III and VII sometimes nearly or entirely lost in females; basal bands usually 0.20–0.25 length of terga in females, 0.25–0.30 in males. Sterna usually entirely pale-scaled.

Pupa (Neotype) (Fig. 2A, B).—Character and arrangement of setae as figured. *Cephalothorax:* Lightly tanned, legs and metathorax darker. *Trumpet:* Moderately tanned, almost cylindrical, gradually widened distally, index 5.0; tracheoid area darkened, extending 0.33 from base; pinna oblique, about length of tracheoid area. *Abdomen:* Lightly tanned, terga I–V darker in middle; length 3.2 mm. *Genital lobe:* Lightly tanned; length 0.4 mm. *Paddle:* Lightly tanned, midrib and buttress darker; midrib distinct except at apex; length 0.8 mm, width 0.6 mm, index 1.3.

The alloneotype resembles the neotype except as follows: trumpet index 6.2; abdominal length 3.3 mm; genital lobe length 0.2 mm; paddle 0.9 × 0.7 mm with same index.

Table 1 lists the range and modal number of branches for pupal setae observed in the types and associated specimens. Diagnostic and variable characters include the following. *Cephalothorax:* Seta 1-CT with 3 or 4 branches; 2-CT with 4 or 5 branches; 3, 4-CT usually with 3 branches (2–4); 6, 7, 9, 11-CT usually double; 10-CT with 5–13 branches, often with about 8. *Trumpet:* Index 4.9–6.2, mean 5.4. *Abdomen:* Setae 6-I, II single; 7-I, II usually double; 1-II multiple (14–24); 1-III–V frequently with at least 6 branches; 2-II, VII lateral to seta 1, 2-III–VI mesal to seta 1; 5-IV often with 4 branches, rarely double (2–5); 5-V, VI usually double; 6-III–VI usually with 3 or 4 branches. *Paddle:* Index 1.2–1.4, mean 1.3.

Larva (Neotype) (Fig. 3).—Placement and attributes of setae as figured. *Head:* Length 0.8 mm, width 1.1 mm; mainly lightly tanned, labiogula, posterior 0.5 of lateralia and posterior border of dorsal apotome moderately tanned; dorsal apo-

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Fig. 2. *Culex* (*Culex*) *molestus* Forskål, neotype male. A, B, Pupa (A, dorsolateral aspect of cephalothorax (left side); B, dorsal and ventral aspects of left side of metathorax and abdomen). C–H, Genitalia, aspects as indicated (C, gonocoxite; D, phallosome; E, F, lateral plate and aedeagal sclerite; G, tergum IX; H, proctiger). Scales in mm.

Table 1. Number of branches for pupal setae of *Culex (Culex) molestus* Forskål.[a]

Seta Number	Cephalothorax CT	Abdominal Segments									Paddle P
		I	II	III	IV	V	VI	VII	VIII	IX	
0	—	—	—	1, 2 (1)	1	1	1	1	—	—	—
1	3, 4 (4)[b]	36–75 (62)	14–24 (19)	5–9 (9)	5–9 (6)	4–7 (6)	3–7 (4)	3–5 (5)	—	1	1, 2 (1)
2	4, 5 (4)	1–4 (1)	1	1	1	1	1	1, 2 (1)	—	—	—
3	2–4 (3)	2, 3 (2)	2	2, 3 (2)	3–5 (5)	2, 3 (2)	2–4 (2)	1–3 (2)	1–3 (2)	—	1
4	2–4 (3)	4–8 (5)	2–7 (4)	4–8 (4)	2–5 (2)	3–6 (4)	2–6 (3)	1, 2 (2)	—	—	—
5	3–7 (6)	4–8 (5)	4–6 (5)	4–10 (5)	2–6 (4)	2, 3 (2)	1, 2 (2)	1–3 (2)	—	—	—
6	1–5 (2)	1	1	2–4 (3)	2–5 (3)	3–6 (4)	3–6 (4)	4–10 (5)	—	—	—
7	2, 3 (2)	2–4 (2)	2, 3 (2)	4–8 (5)	3–5 (3)	3–6 (5)	1	1	—	—	—
8	4–7 (4)	—	—	3–5 (3)	3, 4 (3)	2–4 (4)	2–4 (3)	2–5 (4)	6–11 (7)	—	—
9	1, 2 (2)	1, 2 (1)	1	1	1	1	1	4–6 (5)	—	—	—
10	5–13 (8)	a[c]	2, 3 (2)[d]	2, 3 (2)	2	—	1, 2 (1)	1	—	—	—
11	2, 3 (2)	1, 2 (1)	3, 5[e]	1	1	1, 2 (1)	1–3 (2)	1–4 (2)	—	—	—
12	2–4 (3)	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1	1	1	1, 2 (1)	—	—

[a] Based on counts made on the neotype, alloneotype, and 10 specimens collected with the type-specimens.
[b] Range (mode).
[c] Alveolus only.
[d] Occurring on one side in the alloneotype, and in 2 other specimens.
[e] Occurring with seta 10-II in 2 specimens.

tome with moderately tanned spots as follows: crescentic spot just anterior to each seta 8-C, small median spot immediately posterior to bases of seta 5-C, median transverse oval spot midway between bases of seta 5-C and posterior margin of head, latter with small spot on either side laterally. Median labral plate narrow but distinct, anterior margin slightly emarginate between insertions of seta 1-C. Labiogula longer than broad, broader posteriorly; hypostomal suture complete, extended posterolaterally from posterior tentorial pit to near collar. Collar moderately developed along lateralia, heavily tanned. Mouthparts developed for filter-feeding. Dorsomentum with 12 teeth on either side of median tooth. *Antenna:* Length 0.4 mm, 0.5 length of head; moderately tanned, mesal surface with dark spot at base; part proximal to seta 1-A with strongly-developed aciculae, distal part slender and smooth; seta 1-A 0.7 from base. *Thorax:* Integument hyaline, tubercles of all large setae moderately tanned; setae 1-3-P and 9-12-P, M, T on common tubercles. *Abdomen:* Integument hyaline, tubercles of setae 7-I, 6-I–VI and 1, 3, 5-VIII moderately tanned, tubercle of setae 2, 3-X heavily tanned. *Segment VIII:* Comb with 48 and 40 scales on left and right sides, respectively; scales short, evenly fringed on sides and apex, arranged in 4 irregular rows. *Siphon:* Index 3.35; imperceptibly sigmoid in lateral view, broadest at base; moderately tanned, darker at base and apex; acus attached, longer on posterior side of attachment. Pecten of either side with 14 spines, spines rather short, larger spines with 3 or 4 long basal denticles. Seta 1-S in 4 pairs, 1c-S almost directly anterior of 1b-S. *Segment X:* Saddle complete; moderately tanned, darker dorsally; posterodorsal area with minute spicules; length 0.3 mm, saddle/siphon index 3.60. 4-X with 1 unpaired and 6 paired setae, each seta arising from the grid. Anal papillae elongate, subacutely tapered; dorsal and ventral pairs of equal length, about length of saddle.

The alloneotype resembles the neotype except for the following principal differences: length of head 0.9 mm, width 1.2 mm; dorsal apotome moderately tanned, darker posteriorly, spots less distinct; length of antenna nearly 0.5 mm; comb with 43 and 46 scales on left and right sides, respectively; siphon index 3.65, pecten with 11 and 13 spines on left and right sides, respectively; length of saddle 0.4 mm, saddle/siphon index 3.53.

The range and modal number of branches of larval setae determined from the types and associated specimens are given in Table 2. A description of diagnostic and variable characters follows. *Head:* Seta 1-C slender, tapered distally, slightly bent mesad; 3-C distinct, 2-C absent; 4-C single, rather long; 5-C usually with 5 branches (4–7); 6-C commonly with 4 or 5 branches (3–6), more frequently with 4; 7-C resembles 5, 6-C, most often with 10 branches (8–13); 8-C usually double (2, 3); 10-C double; 11-13-C double or triple, more frequently double; dorsomentum frequently with 12 teeth (10–13) on either side of median tooth. *Thorax:* Setae 1-3-P all single, nearly of equal length; 4, 7, 8-P usually double, 4-P with 3 branches on right side of neotype only, 7-P with 3 branches on left side of neotype and in one other specimen examined, 8-P with 3 branches on left side of alloneotype only; 11-P usually with 4 or 5 branches (3–6). Seta 1-M single, about 0.5 of 3-M; 3-M single; 4-M double, single in alloneotype only. Seta 1-T short, 0.5 or less length of 2-T. *Abdomen:* Seta 3-I, VII usually single, occasionally double; seta 6-I–VI long, 6-I, II normally with 3 or 4 branches, 6-II double in one specimen examined, 6-III–VI usually double; 7-I usually double; 1-III–VI

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neotype
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usually double, one branch longer than the other. *Segment VIII:* Comb with 38–53 scales, mean 45; seta 3-VIII usually with 8 branches (7–9); seta 5-VIII usually with 4 branches (3–5). *Siphon:* Slightly S-shaped in lateral view; index 3.01–5.77, mean 3.96 (for 77 specimens from Rosetta, Alexandria, and Cairo); pecten with 11–18 spines, mean 14. *Segment X:* Saddle/siphon index 2.97–4.16, mean 3.54; seta I–X usually single (1, 2); 4-X with 6 paired setae, sometimes with an additional unpaired seta.

Behavior/physiology (observations by AMG).—Approximately 80% of the F_1 females obtained from specimens collected at Rosetta laid fertile autogenous eggs in the laboratory. Individuals mated freely in 30 × 30 × 30 cm cages and in glass cylinders 20 cm long and 10 cm in diameter. Most autogenous rafts were laid three days after the females had emerged, but some were laid up to two weeks after emergence. Females fed aggressively on the arm of a human following deposition of autogenous rafts.

DISCUSSION

There is no doubt that the neotype, alloneotype, and associated specimens are conspecific with the mosquito Forskål (1775) described and named *Culex molestus.* Forskål's diagnosis, description, and comments contain several critical clues that, when combined, eliminate the other species found in the type-localities of Rosetta, Cairo, and Alexandria. The clues are: (1) proboscis dark above, ash-colored below; (2) dorsum [abdomen] dark, with 6 pale bands; (3) size and appearance like *Cx. pipiens* Linnaeus; (4) tibiae dark; (5) wings dark; (6) tremendously abundant in all three type-localities; (7) bothers sleepers at night [i.e., bites man]; and (8) difficult to avoid unless with well closed curtains [i.e., inside homes].

Of 25 mosquito species confirmed from Egypt west of the Gulf of Suez, there are 13 (other than *molestus*) that could have been collected by Forskål which we must compare with the clues listed above. Two *Aedes* species can be eliminated quickly. *Aedes (Ochlerotatus) caspius* (Pallas) and *Ae. (Och.) detritus* (Haliday) have extensive pale scales on the proboscis, legs, wings, and abdomen. Furthermore, *Ae. caspius* has distinct pale tarsal bands and *detritus* has never been collected near Cairo. *Culiseta (Allotheobaldia) longiareolata* (Macquart) is very abundant in all three type-localities, but is very large, has pale scales on the wings, pale longitudinal stripes on the legs and does not bite man. *Culex (Lasiosiphon) adairi* Kirkpatrick and *Cx. (Neoculex) deserticola* Kirkpatrick are small pale species only collected infrequently in desert rock pools/wells, and never recorded biting man or from the Nile Delta. *Culex (Barraudius) pusillus* Macquart is a small dark species without pale bands on the abdomen, having only pale lateral patches. Apparently, *Cx. pusillus* is entirely autogenous, as it has not been observed feeding and could not be induced to bite (Kirkpatrick, 1925). *Culex (Cux.) mimeticus* Noé, *Cx. (Cux.) poicilipes* (Theobald), and *Cx. (Cux.) tritaeniorhynchus* Giles all possess a very distinct pale band on the proboscis, besides, only *poicilipes* has

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Fig. 3. *Culex (Culex) molestus* Forskål, neotype male, larva. A, Head (dorsal and ventral aspects of left side). B, Thorax and abdominal segments I–VI (dorsal and ventral aspects of left side). C, Dorsomentum. D, Abdominal segments VII–X (left side). E, Pecten spine. F, Comb scale. Scales in mm.

Table 2. Number of branches for setae of the fourth-instar larva of *Culex (Culex) molestus* Forskål.[a]

Seta Number	Head C	Thorax			Abdominal Segments								
		P	M	T	I	II	III	IV	V	VI	VII	VIII	X
0	9–19 (16)[b]	—	—	—	—	1	1	1	1	1	1	1	—
1	1	1	1	2–4 (3)	3–5 (4)	1–3 (2)	1–3 (2)	2	1, 2 (2)	2	3, 4 (3)	4–7 (6)	1, 2 (1)
2	—	1	2–5 (3)	1–3 (2)	1	1	1	2	1	1, 2 (1)	1	1	2
3	1	1	1	3–5 (4)	1, 2 (1)	1, 2 (1)	1	1, 2 (1)	1	1	1, 2 (1)	7–9 (8)	1
4	1	2, 3 (2)	1, 2 (2)	2–4 (4)	8–12 (10)	3–7 (4)	1	1	1	1–3 (2)	1	1	5–10 (6)
5	4–7 (5)	1	1	1	2–7 (5)	1, 2 (2)	1–4 (2)	1, 2 (2)	3, 4 (3)	1–4 (3)	1–3 (2)	3–5 (4)	—
6	3–6 (4)	1	1	1	3, 4 (3)	2–4 (3)	1–3 (2)	1, 2 (2)	1–3 (2)	2	10–17 (12)	1a–S	—
7	8–13 (10)	2, 3 (2)	1	7–10 (10)	2, 3 (2)	3–5 (4)	2, 3 (2)	2	2	1	1	2–4 (3)	—
8	2, 3 (2)	2, 3 (2)	5–9 (7)	9–18 (11)	—	1	5–9 (6)	6–10 (7)	4–8 (7)	2–5 (3)	2–5 (4)	1b–S	—
9	3–7 (5)	1	5–8 (6)	5–9 (7)	2–5 (2)	1	1	1	1, 2 (1)	1	3–8 (3)	2–4 (3)	—
10	2	1	1	1	1	1	1	1	1	1	1	1c–S	—
11	2, 3 (2)	3–6 (4)	2–4 (2)	1–3 (2)	3–10 (5)	2–5 (2)	1, 2 (2)	2, 3 (3)	1–3 (3)	2–4 (3)	2–4 (2)	1–4 (3)	—
12	2, 3 (2)	1	1	1	1–3 (2)	1, 2 (2)	1–3 (2)	1, 2 (1)	1	1	1	1d–S	—
13	2, 3 (2)	—	15–27 (23)	4–6 (4)	1–3 (2)	10–23 (15)	2–4 (3)	2, 3 (3)	2, 3 (3)	22–43 (28)	2, 3 (3)	2–4 (2)	—
14	—	1, 2 (1)	15–26 (20)	—	—	—	1	1	1	1	—	1	—
15	3–5 (3)	—	—	—	—	—	—	—	—	—	—	—	—

[a] Based on counts made on the neotype, alloneotype, and 10 specimens collected with the type-specimens.
[b] Range (mode).

been collected (infrequently) in the Delta of Egypt. *Culex mimeticus* has distinct pale scaling on the wings and is known in Egypt only from the far western oases, while *tritaeniorhynchus* is known only from the southwestern oases. *Culex (Cux.) perexiguus* Theobald is somewhat similar to *molestus* and seasonally common in the Delta, but is darker, has a pale stripe on the hindtibia, and normally feeds on birds. *Culex (Cux.) theileri* Theobald is a large pale species that is not very common in the Delta and has pale longitudinal stripes on the femora, tibiae, and first tarsomeres. *Culex (Cux.) laticinctus* Edwards is morphologically similar to *molestus* except for much broader pale bands on the abdomen. However, *Cx. laticinctus* is not known to bite man or enter houses and is uncommon in the Delta. We did not find this species during 30 days of collecting all over the Delta, but did see several specimens in collections that were made near Alexandria in the 1920's. Next to *molestus*, *Cx. (Cux.) antennatus* (Becker) was the most common *Culex* encountered in the Delta. This species bites man, but prefers large domestic animals. It is exophilic and easily separated from *molestus* by the absence of pale abdominal bands and the presence of pale lateral patches on only the more posterior terga.

As seen from the above, only one species presently occurs in the Nile Delta of Egypt and in the three type-localities that conforms to Forskål's description. This is the species called *pipiens* by Kirkpatrick (1925) and Knight and Abdel Malek (1951). It is the most abundant mosquito in the three type-localities, it avidly bites man and is difficult to keep out of houses and even hotels. This is the species we collected, reared, and selected to serve as the neotype, alloneotype, and associated specimens of *Culex molestus*.

Morphological variation.—*Culex molestus* Forskål was regarded as a junior synonym of *Culex pipiens* Linnaeus until Marshall and Staley (1937) revived the name for strains exhibiting autogeny, anthropophily, and stenogamy. Subsequently, specimens looking like *pipiens*, but exhibiting these behavioral/physiological traits, especially autogeny, have been treated under the name of *molestus*, either as a species, subspecies, or infraspecific form.

Morphological differences between man-biting and man-ignoring forms of *pipiens* were first noted by Ficalbi (1890) who observed that adults of the former were lighter in general coloration and lacked prominent pale spots at the apices of the femora and hindtibia. In 1896, Ficalbi noted differences in the length of the maxillary palpi of males as compared to the length of the proboscis. Much later, Marshall and Staley (1935a, b, 1937), Jobling (1938), and Christophers (1951) described additional adult characters, and a number of egg and larval characters, by which the autogenous form (*molestus*) could be distinguished from the anautogenous one (*pipiens*). These characters have proven to be so variable that most workers are unwilling to regard these forms as distinct species, or even subspecies. In fact, we made detailed comparisons between Egyptian specimens and a significant number of specimens of *Cx. pipiens* reared from larvae collected in a rural area near Veberöd, Sweden, and were unable to detect any constant morphological differences. Reference is made to this comparison in the paragraphs which follow.

Specimens conforming to the neotype of *molestus* were reared from larvae collected in all of the areas surveyed in Egypt. However, a small number of relatively dark adults were obtained from larvae collected in more or less rural

areas. These specimens, mostly females, are characterized by having the basal bands of the abdominal terga reduced and/or indistinct, but are otherwise indistinguishable from the typical form. We also collected a small number of larvae in which the head and siphon were darker than usual. These were always collected with typical larvae from which they differed only in their more swarthy appearance. Some of the dark larvae developed into dark adults. We found neither dark larvae nor dark adults in the urban areas that were surveyed—including Aswan, Cairo, Alexandria, Rosetta, Port Said, and Suez. Knight and Abdel Malek (1951) also did not find dark adults in the Cairo area. The examination of hundreds of specimens resembling the neotype has shown that morphological variation is fairly constant and random for this form in Egypt. For this reason, the dark specimens appear to be nothing more than sporadic variants.

In general, adults examined from Egypt were scarcely paler than specimens from Sweden. Similarly, Lewis (1945) reported that individuals of *molestus* occurring between Khartoum and the Egyptian frontier were not appreciably paler than specimens of *pipiens* from Ethiopia and Sudan. Pale spots were always seen at the apices of the femora and the hindtibia, but varied considerably in distinctness. Knee spots are apparently weakly developed and normally cannot be seen with the unaided eye in specimens from purely autogenous strains (cf. Marshall and Staley, 1937; Jobling, 1938; and Christophers, 1951).

The abdominal sterna of specimens traditionally identified as *pipiens* usually, but not always, have prominent median patches of dark scales. This is true of specimens examined from Sweden. On the other hand, in specimens commonly recognized as *molestus,* the sterna are usually entirely pale or have a few indistinct dark scales in the middle. This is the case with specimens from Egypt. Overall, the sternal scaling is not too variable: the dark scales are usually either present or entirely absent, or nearly so, with few specimens exhibiting an intermediate condition. There appears to be a definite selection for entirely pale sterna in autogenous strains and populations occurring in arid areas.

Various authors maintain that the most reliable distinction between adults of *molestus* (autogenous strains) and *pipiens* (anautogenous strains) is the length of the maxillary palpi relative to the length of the proboscis in males. In *pipiens,* palpomeres 1–4 are said to be longer than the proboscis, and in *molestus* they are supposedly shorter than the proboscis. Christophers (1951) attributed this difference to the greater length of palpomere 4 in *pipiens*. He found that the length of palpomere 4 relative to that of palpomeres 1–3 was 2.71 in specimens he recognized as *pipiens* and 3.21 in specimens he called *molestus*. The variability of this character, however, is clearly evident in specimens from Egypt and Sweden. In males from Cairo, palpomeres 1–3 were found to be 2.75 to 3.87 times the length of palpomere 4 (Knight and Abdel Malek, 1951), while the palpi of males from Sweden often extend beyond the tip of the proboscis by less than the length of palpomere 5. Service (1968) found palpomere 4 was 2.95 ± 0.38 times as long as palpomeres 1–3 in British *pipiens*. According to Vinogradova and Fomenko (1968), this character is unreliable for separating specimens from Uzbekistan, USSR, and pointed out that it was useful "only in combination with biological criteria."

Jobling (1938) noted another difference in the maxillary palpi of males. He described palpomere 3 as being "almost straight" in *pipiens* and "usually curved"

in *molestus*. We have examined numerous specimens from many localities in northern Africa, southwestern Asia, and Europe, and have found that palpomere 3 is usually straight or only slightly curved in lateral view.

Marshall and Staley (1938) and Marshall (1938, 1944) characterized the basal pale bands of the abdominal terga as being convex or bilobed in anautogenous females (*pipiens*) and straight in autogenous ones (*molestus*). Christophers (1951) remarked that the bands "strikingly differentiate the forms," but did not describe their appearance. Jobling (1938) also compared the tergal bands in autogenous and anautogenous females and found that they were of no diagnostic value. We have noted that the bands are always yellowish in color, but vary considerably in size and shape, sometimes also from terga to terga in a single specimen.

Neither the male nor female genitalia offer characters for the separation of individuals from autogenous and anautogenous strains. Differences have been noted in the number of setae on the ninth tergum in both sexes, but this character is too inconstant to be of diagnostic value (cf. Marshall and Staley, 1935b, 1937; Jobling, 1938; Christophers, 1951; and Knight and Abdel Malek, 1951). Christophers (1951) indicated that the dorsal arms of the male phallosome may possibly be more truncate in *pipiens* than *molestus*. The tips of the dorsal arms, however, frequently exhibit minor structural differences, although they are always blunt, and their appearance is easily influenced by positioning and the posture of the phallosome. Measurements of DV/D (Sundararaman, 1949) have not been studied in males from purely autogenous and anautogenous strains. Knight and Abdel Malek (1951) found DV/D ratios to vary from -0.14 to $+0.02$ (mean -0.07) in specimens from Cairo, while Service (1968) obtained a mean ratio of -0.10 ± 0.02 in males from Brownsea Island and elsewhere in Britain. Using the method of Barr (1957), we obtained DV/D ratios ranging from -0.19 to zero (mean -0.09) for males from Sweden.

Marshall (1944) stated that the pupae of *pipiens* are indistinguishable from those of *molestus,* but provided no comparative data. Apparently, little or no attention has been given to pupal characters. We were unable to find any morphological distinctions between pupae from Sweden and the type-locality of *molestus*. The chaetotaxy and various character measurements were virtually identical. Trumpet indices ranged from 4.9 to 6.2 (mean 5.4) in Egyptian specimens, and from 4.8 to 6.9 (mean 5.5) in pupae from Sweden. Paddle indices varied from 1.2 to 1.4 (mean 1.3) in the former, and from 1.2 to 1.6 (mean 1.4) in the latter.

Egyptian specimens exhibited the greatest amount of variation in the length of the larval siphon. This is evident from the range of siphon indices calculated for specimens from the three type-localities listed by Forskål: 27 specimens from Rosetta yielded indices between 3.01 and 4.15 (mean 3.61), indices obtained from 24 specimens collected in Alexandria ranged from 3.80 to 5.07 (mean 4.50), and indices for 26 larvae from Cairo varied from 3.20 to 5.77 (mean 3.82). Overall, these values (3.01–5.77, mean 3.96) are higher than those previously obtained by Knight and Abdel Malek (1951) who found indices ranging from 2.7 to 4.7 (mean 3.7) in 98 specimens from the Cairo area. Kirkpatrick (1925) stated that the siphon index of Egyptian specimens was usually about 4.5 but varied from about 4.0 to about 5.2. Jobling (1938) and Lewis (1945) recorded indices varying from 3.5 to 4.7 (mean 3.9) and 3.5 to 5.3 (mean 4.3) in specimens from Palestine and the

Sudan, respectively. For comparison, we measured the siphons of 106 *pipiens* larvae from the aforementioned Swedish population and obtained an average index of 4.99 with values ranging between 3.80 and 5.87. Simple *t*-test comparisons showed that the means from the Egyptian and Swedish larvae were significantly different ($P < 0.005$), yet there is considerable overlap in the range of indices. A large overlap was also observed for another index of siphon length, the saddle/siphon index, but a significant difference was likewise found between the means—Egyptian specimens showed a mean of 3.54 for indices ranging from 2.97 to 4.16, while specimens from Sweden had a mean of 4.04 with indices between 3.48 and 4.63. Despite the differences noted here, the character of the larval siphon is too inconstant over the whole range of *pipiens* to reflect specific or subspecific differences. Particularly illustrative of this is the mean siphon index of 4.06 ± 0.24 and the mean saddle/siphon index of 3.27 ± 0.18 that Service (1968) obtained from measurements made on larvae of *pipiens* from Britain. These values are undoubtedly significantly lower than those obtained from Swedish larvae, and the saddle/siphon index is considerably, if not significantly, lower than that obtained from the Egyptian specimens. Compare also the siphon indices obtained by Callot (1957) for specimens of *pipiens* and *molestus* (as *autogenicus* Roubaud) from France: mean of 3.8 for *pipiens* versus 3.2 for *molestus*.

No other significant differences were found between the Egyptian and Swedish larvae. The chaetotaxy was found to be indistinguishable with many setae exhibiting the same modal number of branches. Similarly, there was essentially no difference in the form or number of comb scales or pecten spines. The comb of Egyptian specimens frequently possessed 45 scales, but the number ranged from 38 to 53. Swedish specimens had 37 to 57 scales per comb with a modal number of 44. The modal number of pecten spines for both populations was 14 and the ranges were nearly identical, 11 to 18 for Egyptian larvae and 11 to 17 for those from Sweden. In 1951, Knight and Abdel Malek found almost exactly the same range and average number of pecten spines in specimens from Cairo: minimum 11, maximum 19 and 14.2 for the mean. Natvig (1948) recorded ranges of 28 to 60 (mean 41) and 12 to 18 (mean 15) for the number of comb scales and pecten spines, respectively, in specimens of *pipiens* examined from Scandinavia and Finland. Natvig, however, could not differentiate the larvae of *pipiens* and *Cx. torrentium* Martini and considered all larvae studied to be *pipiens*.

Jobling (1938) noted slight differences in the number of dorsomental teeth in specimens he recognized as *pipiens* and *molestus*. He observed 14 to 24 teeth, with a mean of 18, in the former and 18 to 24 teeth with a mean of 21 in the latter. Comparison with specimens from Egypt and Sweden indicates that the number of dorsomental teeth is quite variable. Egyptian specimens examined by us had 20 to 26 teeth with a modal number of 24, while Knight and Abdel Malek (1951) reported that specimens from Cairo had between 16 and 26 teeth with an average of 20.4. In larvae from Sweden, the number of teeth varied from 16 to 22 and the mode was 20. Therefore, the Swedish specimens had slightly more teeth than the English larvae which Jobling (1938) treated under the name of *pipiens*, and more closely resembled his specimens of *molestus* with respect to this character.

The number of branches for setae 1-S and 4-X, the length of the anal papillae, and the shape of the siphon, spiracular apodeme, and spiracular valves have been

used to distinguish larvae of *molestus* and *pipiens,* but all have been found to be much too variable for this purpose.

No discrete or significant differences have been found in the size or structure of eggs obtained from autogenous and anautogenous strains (cf. Roubaud, 1935; Christophers, 1945; Cervone, 1957; Idris, 1960; Lincoln, 1965; and Hinton, 1968). Differences, however, have been reported in the size and shape of the egg rafts. Rafts obtained from anautogenous females are generally larger, usually containing 150–300 eggs, but the number of eggs varies considerably, e.g., Jobling (1938) examined rafts containing 77–505 eggs. Rafts deposited by autogenous females are generally smaller, containing 7–125 eggs (as reflected in the combined data of Marshall and Staley, 1935b and Jobling, 1938). Anautogenous rafts are usually elongate oval in shape (boat-shaped). Autogenous rafts are commonly oval, but may assume a variety of shapes: circular, oblong, square, rectangular, triangular, ribbonlike, or irregular. For comparison, studies on the Cairo population (Knight and Abdel Malek, 1951) revealed that over 40% of the rafts obtained from either autogenous or anautogenous females were boat-shaped. Furthermore, rafts obtained from blooded females contained 5–162 eggs (5–148 with human blood; 20–162 with pigeon blood), while those obtained from unfed females contained only 12–85 eggs. Considering that only a very small percentage of the females from the Cairo population lay autogenous rafts (0–4% depending on the collection site, mean 1.1%), the size of rafts obtained from blooded females is small when compared to the size of those reported for anautogenous populations from Europe.

Taxonomic status.—The current status of *molestus* as a species is based on Knight (1978), who elevated the name because of evidence for premating behavioral isolation in attempted crosses between *molestus* and *quinquefasciatus* (as *Cx. fatigans* Wiedemann) in Australia (Miles, 1977a, b). Miles followed Drummond (1951) in ascribing the name *molestus* to a member of the *pipiens* complex in Australia that exhibited autogeny, stenogamy, and anthropophily. He also assumed that the morphological differences described by Marshall and Staley (1937) to differentiate *molestus* from *pipiens* were decisive. These morphological "differences" are no longer recognized as valid for many populations of *molestus* and *pipiens.* Furthermore, autogeny and stenogamy are now recognized as genetic traits (Roubaud, 1929; Knight, 1951; Spielman, 1957; Aslamkham and Laven, 1970). In fact, autogeny is known to occur in many mosquito species that also exhibit anautogeny (Rioux et al., 1975). Such behavioral/physiological traits can be very useful in defining populations within species, or occasional sibling species; however, they should not be used as *carte blanche* criteria for differentiating species.

We feel the use of the name *molestus* by Miles (1977a, b), and Miles and Paterson (1979) for the aforementioned Australian population was unwarranted because an autogenous, stenogamous, and anthropophilic population is nothing more than a behavioral/physiological variant of *pipiens.* Accordingly, the crosses conducted by Miles (1977a, b) were between *pipiens* and *quinquefasciatus* and the premating isolation barrier he detected lends no support to the name *molestus,* but does support the elevation of *quinquefasciatus* to species status by Sirivanakarn (1976). Past crosses between members of populations called *molestus* and *pipiens* on the basis of behavioral/physiological criteria usually resulted in interfertility (Knight, 1951), with infrequent reports of non-fertility (Marshall and Staley, 1937; Spiel-

man, 1967). Most of the negative crosses are now attributable to incompatibility between strains of the rickettsial symbiont, *Walbachia pipientis* Hertig, or an absence of the symbiont in one side of the cross (Yen and Barr, 1973), which may be influenced further by environmental pressure during colonization or maintenance in the laboratory (Irving-Bell, 1983). Other negative crosses may reflect genetic premating barriers which are more pronounced in certain isolated populations, but are incomplete in others (Spielman, 1979; Bullini, 1982). Even populations having fairly pronounced genetic premating barriers do not exhibit the Nei's genetic distances that typify mosquito sibling species (Bullini, 1982). Accordingly, we cannot accept species status for *molestus,* or even subspecies status, since as pointed out by Barr (1981) autogenous-stenogamous populations and anautogenous-eurygamous populations that are sympatric and called subspecies do not agree with Mayr's (1963) definition of subspecies. Autogenous, stenogamous, and anthropophilic populations or individuals should be identified as behavioral/physiological variants of *pipiens,* without using another name.

Literature Cited

Aslamkham, M. and H. Laven. 1970. Inheritance of autogeny in the *Culex pipiens* Complex. Pak. J. Zool. 2: 121–147.

Barr, A. R. 1957. The distribution of *Culex p. pipiens* and *C. p. quinquefasciatus* in North America. Am. J. Trop. Med. Hyg. 6: 153–165.

————. 1981. The *Culex pipiens* Complex, pp. 123–136. *In* R. Pal, J. B. Kitzmiller and T. Kanda, eds. Cytogenetics and genetics of vectors. Elsevier Biomedical Press, New York. 265 pp.

Belkin, J. N. 1977. *Quinquefasciatus* or *fatigans* for the tropical (southern) house mosquito (Diptera: Culicidae). Proc. Entomol. Soc. Wash. 79: 45–52.

Bullini, L. 1982. Genetic, ecological, and ethological aspects of the speciation process, pp. 241–264. *In* C. Barigozzi, ed. Mechanisms of speciation. Prog. Clin. Biol. Res. 96: 1–546.

Callot, J. 1957. Sur *Culex torrentium* Martini. Ann. Parasitol. Hum. Comp. 32: 438–442.

Cervone, L. 1957. Sulla struttura perimicropilare dell'uovo in *Culex autogenicus* dell'Agro Pontino. Ric. Clin. Ist. Sup. Sanita (Rome) 20: 695–701.

Christophers, S. R. 1945. Structure of the *Culex* egg and egg-raft in relation to function (Diptera). Trans. R. Entomol. Soc. Lond. 95: 25–34, 4 pls.

————. 1951. Note on morphological characters differentiating *Culex pipiens* L. from *Culex molestus* Forskål and the status of these forms. Trans. R. Entomol. Soc. Lond. 102: 372–379.

Drummond, F. H. 1951. The *Culex pipiens* Complex in Australia. Trans. R. Entomol. Soc. Lond. 102: 369–371.

Ficalbi, E. 1890. Notizie preventive sulle zanzare italiane. VIª. Nota preventiva. Quistioni zoologiche intorno al *Culex pipiens* e descrizione di una specie nuova (*Culex phytophagus*). Boll. Soc. Entomol. Ital. 21: 124–131.

————. 1896. Revisione sistematica delle specie europe della famiglia delle Culicidae. Boll. Soc. Entomol. Ital. 28: 108–312.

Forskål, P. 1775. Descriptiones animalium, avium, amphibiorum, piscium, insectorum, vermium, quae in itinere orientali observavit. Mölleri, Hauniae. 164 pp.

Harbach, R. E. and K. L. Knight. 1980. Taxonomists' glossary of mosquito anatomy. Plexus Publishing, Inc., Marlton, New Jersey. xi + 415 pp.

Hinton, H. E. 1968. Structure and protective devices of the egg of the mosquito *Culex pipiens*. J. Insect Physiol. 14: 145–161.

Idris, B. E. M. 1960. Die Entwicklung im normalen Ei von *Culex pipiens* L. (Diptera). Z. Morphol. Oekol. Tiere 49: 387–429.

Irving-Bell, R. J. 1983. Cytoplasmic incompatibility within and between *Culex molestus* and *Cx. quinquefasciatus* (Diptera: Culicidae). J. Med. Entomol. 40: 44–48.

Jackson, B. D. 1913. Catalogue of the Linnean specimens of Amphibia, Insecta, and Testacea, noted by Carl von Linné. Proc. Linn. Soc. Lond. (Suppl.) 1912–1913: 1–48.

Jobling, B. 1938. On two subspecies of *Culex pipiens* L. (Diptera). Trans. R. Entomol. Soc. Lond. 87: 193–216.

Kirkpatrick, T. W. 1925. The mosquitoes of Egypt. Government Press, Cairo. 224 pp.

Knight, K. L. 1951. A review of the *Culex pipiens* Complex in the Mediterranean subregion (Diptera, Culicidae). Trans. R. Entomol. Soc. Lond. 102: 354–364.

————. 1972. History of mosquito systematics Part I. Eighteenth Century. Mosq. Syst. 4: 10–15.

————. 1978. Supplement to a catalog of the mosquitoes of the world (Diptera: Culicidae). Thomas Say Found. 6 (Suppl.): 1–107.

Knight, K. L. and A. A. Abdel Malek. 1951. A morphological and biological study of *Culex pipiens* in the Cairo area of Egypt. Bull. Soc. Fouad Entomol. 35: 175–185.

Knight, K. L. and A. Stone. 1977. A catalog of the mosquitoes of the world (Diptera: Culicidae). 2nd Edition. Thomas Say Found. 6: 1–611.

Lewis, D. J. 1945. Observations on the distribution and taxonomy of Culicidae (Diptera) in the Sudan. Trans. R. Entomol. Soc. Lond. 95: 1–24, 2 maps.

Lincoln, D. C. R. 1965. Structure of the egg-shell of *Culex pipiens* and *Mansonia africana* (Culicidae, Diptera). Proc. Zool. Soc. Lond. 145: 9–17.

Marshall, J. F. 1938. The British mosquitoes. British Museum (Natural History), London. xi + 341 pp. and 20 pls.

————. 1944. The morphology and biology of *Culex molestus*: observational notes for investigators. British Mosquito Control Institute. Pamphlet No. 34. iv + 15 pp.

Marshall, J. F. and J. Staley. 1935a. 'Autogenous' strains of '*Culex pipiens*' (Diptera, Culicidae). Nature (Lond.) 136: 641.

————. 1935b. Some adult and larval characters of a British "autogenous" strain of *Culex pipiens* L. Parasitology 27: 501–506.

————. 1937. Some notes regarding the morphological and biological differentiation of *Culex pipiens* Linnaeus and *Culex molestus* Forskål (Diptera, Culicidae). Proc. R. Entomol. Soc. Lond. Ser. A Gen. Entomol. 12: 17–26.

Mayr, E. 1963. Animal species and evolution. The Belknap Press of Harvard University Press, Cambridge, Massachusetts. xiv + 797 pp.

Miles, S. J. 1977a. Laboratory evidence for mate recognition behavior in a member of the *Culex pipiens* Complex (Diptera: Culicidae). Aust. J. Zool. 25: 491–498.

————. 1977b. Assortative mating between *Culex fatigans* and *C. molestus* (Diptera, Culicidae) under simulated field conditions. J. Aust. Entomol. Soc. 16: 389–392.

Miles, S. J. and H. E. Paterson. 1979. Protein variation and systematics in the *Culex pipiens* group of species. Mosq. Syst. 11: 187–202.

Natvig, L. R. 1948. Contributions to the knowledge of the Danish and Fennoscandian mosquitoes— Culicini. Nor. Entomol. Tidsskr. (Suppl. I). xxiii + 567 pp., 12 pls., 1 map.

Rioux, J.-A., H. Croset, J. Pech-Périeres, E. Guilvard and A. Belmonte. 1975. L'autogenese chez les Dipteres Culicides. Tableau synoptique des espèces autogènes (1). Ann. Parasitol. Hum. Comp. 50: 134–140.

Roubaud, E. 1929. Cycle autogène d'attente et générations hivernales suractives inapparentes chez le moustique commun, *Culex pipiens* L. C. R. Acad. Sci. Paris 188: 735–738.

————. 1935. La microstructure du fletteur de l'oeuf dans les races biologiques de *Culex pipiens*. Bull. Soc. Pathol. Exot. 28: 443–445.

Service, M. W. 1968. The taxonomy and biology of two sympatric sibling species of *Culex, C. pipiens* and *C. torrentium* (Diptera, Culicidae). J. Zool. (Lond.) 156: 313–323.

Sirivanakarn, S. 1976. Medical entomology studies—III. A revision of the subgenus *Culex* in the Oriental Region (Diptera: Culicidae). Contrib. Am. Entomol. Inst. (Ann Arbor) 12(2): 1–272.

Sirivanakarn, S. and G. B. White. 1978. Neotype designation of *Culex quinquefasciatus* Say (Diptera: Culicidae). Proc. Entomol. Soc. Wash. 80: 360–372.

Spielman, A. 1957. The inheritance of autogeny in the *Culex pipiens* Complex of mosquitoes. Am. J. Hyg. 65: 404–425.

————. 1967. Population structure in the *Culex pipiens* Complex of mosquitoes. Bull. W.H.O. 37: 271–276.

————. 1979. Autogeny in *Culex pipiens* populations in nature: effects of inbreeding. Ann. Entomol. Soc. Am. 72: 826–828.

Stone, A., K. L. Knight and H. Starcke. 1959. A synoptic catalog of the mosquitoes of the world (Diptera, Culicidae). Thomas Say Found. 6: 1–358.

Sundararaman, S. 1949. Biometrical studies on intergradation in the genitalia of certain populations of *Culex pipiens* and *Culex quinquefasciatus* in the United States. Am. J. Hyg. 50: 307–314.

Vinogradova, Ye. B. and R. B. Fomenko. 1968. Morphology and biology of *Culex pipiens* L. (Diptera, Culicidae) in Uzbekistan. Entomol. Rev. (Eng. Transl. Entomol. Obozr.) 47: 1–4.

Yen, J. H. and A. R. Barr. 1973. The etiological agent of cytoplasmic incompatibility in *Culex pipiens*. J. Invertebr. Pathol. 22: 242–250.

Zimsen, E. 1964. The type material of I. C. Fabricius. Munksgaard, Copenhagen. 656 pp.